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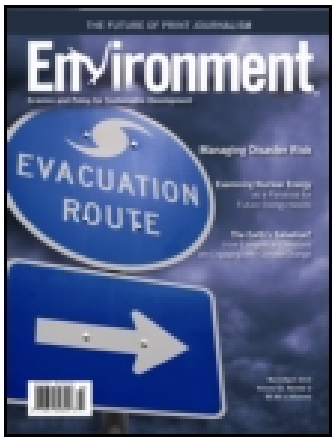


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# The Agenda for Risk Decisionmaking

William W. Lowrance [a]

[a] Life Sciences and Public Policy Program at the Rockefeller University , New York, USA

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# The Agenda for Risk Decisionmaking

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by William W. Lowrance

Our experience over the past decade with issues as diverse as saccharin, polio vaccination, space exploration, contraception, and energy policy has brought broad public recognition of the lessons that nothing can be risk-free, that there are no rewards without risks, and that risktaking for benefit is the essence of human striving.

"Risk" generally has come to mean a factual estimate of the likelihood and severity of deleterious effect. Societal or personal decisions about sources of risk are then understood to be appraisive, taking into account such considerations as benefits, costs, equities, and political dynamics, as well as risks. At issue may be whether a particular risk is "acceptable," or as low as is reasonably achievable, or is similar to risks already accepted or to the risks of alternatives. It has become clear that empirical estimates of risk are value-conditioned (as all questioning is), and that facts can be generated about peoples' values.

"Uncertainty" is not a good synonym for risk. As physical and biological scientists use the term, uncertainty is a description of the precision and accuracy with which something is known or predicted from knowledge. One can easily imagine two hazardous situations (splinter in board versus tank of explosive solvent) about which one's risk-prediction success is equivalently uncertain (being wrong, say, one time in a hundred predictions), but for which the risk stakes clearly are different.

Now, at least in the United States, one rarely hears demands anymore for "zero risk," even from the Congress, and courts no longer declaim that "human life is beyond all price," which never did mean anything.

Although there is no lack of bad news, improvements are occurring. We are putting firmer reins on some technologies, such as nuclear reactors, whose technical development simply outran society's management. And we are cleaning up some messy legacies, such as those of asbestos and toxic waste, about which both our scientific understanding and our values have changed. We have become more restrained in releasing materials into the environment. We have redefined the term "environment" to include not just the outdoors but also workplaces, schools, and homes. And we have become

**WILLIAM W. LOWRANCE** is a senior fellow and director of the Life Sciences and Public Policy Program at the Rockefeller University in New York. This article is adapted with permission from Dr. Lowrance's keynote address to the First International Risk Seminar, Royal College of Physicians in London, March 1983. Proceedings of the seminar are in press, John Libbey & Company Limited, London (1983).

more cautious about taking irreversible actions.

Threats, however, continue to proliferate. Recent additions to the apprehension list include marijuana smoke, textile dust, wood dust, formaldehyde, indoor radon, video display screens, low-frequency electromagnetic radiation from direct-current powerlines, genital herpes, toxic shock syndrome, acquired immune deficiency syndrome, industrial lasers, robotic tools, acid rain . . . . New automobiles, tools, toys, and chemicals will always come along. All of these need attention; some will prove harmless, some will need controlling.

Two attitudinal changes are essential if we are to avoid being overwhelmed emotionally and procedurally by all the emergencies, warnings, false alarms, and controversies: we must come to terms with the essentially tragic nature of these matters, and we must learn to view risk-management actions as societal investments.

## Tragic Confrontation

What is crucial is to recognize that, as with other aspects of modernity, mankind's confrontation of risks to health and well-being has become deeply tragic: we now experience *tragic awareness* of risks and their causes, we have to make *tragic choices* among life-expensive goals, and we must bear *tragic commitments* to the consequences of our choices.

By "tragic," I don't mean merely "unhappy," but rather (with Alfred North Whitehead) a sense of "the solemnity of the remorseless working of things," especially as human will intervenes.

**Nothing is risk-free, there are no rewards without risks, and risktaking for benefit is the essence of human striving.**

In describing flatly *the way things are*, science raises tragic awarenesses about events, causes, and human agency; intentionality displaces "blind chance," and odds and stakes become subject to deliberate alteration. In making tragic choices, we must choose among near-irreconcilable goals with at least some foreknowledge of the likely consequences of our decisions.[1] And tragically we must commit ourselves to the futures chosen, as in protecting deposits of high-level radioactive waste, dealing with the results of genetic engineering, and maintaining the Netherlands dikes. These awarenesses, choices, and commitments may leave us happy or not; but of their solemnity and remorseless working, there can be no question.

Certainly health in the industrial West is, in general, more robust than ever before. We have conquered some of the most dangerous infectious diseases, such as tuberculosis, diphtheria, smallpox, cholera, typhus, and polio, and we have made progress against many others. Scurvy, pellagra, iron-deficiency anemia, and other nutritional diseases have been mastered. Many illnesses that have not yet been eliminated, such as diabetes, have at least been brought under control. Exposure to mercury, lead, arsenic, chromium, and other heavy-metal poisons has been substantially reduced, as has exposure to asbestos, halocarbon solvents, and many other chemicals. Through prediction and protection, damage from storms and earthquakes has been mitigated. Overall, infant mortality continues to decrease and life expectancy to increase. More people are living longer, healthier, more vigorous lives.

## Beyond Ignorance and Resignation

Nonetheless, almost ruefully, we have progressed to an inherently discomfiting state, a state in which we must expect to remain for some time.

Why inherently discomfiting? Because steadily we have broadened our risk concerns to include not only natural catastrophes, infectious diseases, everyday mechanical accidents, and acute poisons, but also large-scale technological accidents, chronic low-level hazards from chemicals, radiation, and noise, and even "lifestyle" vices, such as addictions to tobacco, alcohol, barbiturates, hard drugs, caffeine, and overeating. To our struggle against classical scourges we have added concern about reproductive, genetic, immunological, behavioral, and other debilitations. And of course we continue to create new hazards, to identify risks that may have been present but not recognized, and to resolve to reduce various risks that we have long tolerated.

Now, about many hazards we know enough, scientifically, to "worry,"

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but not enough to know *how much* to worry—or how much protective action to invest. Scientific knowledge has progressed enormously, and we even have the luxury of going around searching for possible trouble. But many scientific disciplines are still in their adolescence and are unable to evaluate risks precisely. (We can detect minuscule traces of manmade chlorocarbons in mothers' milk all over the world, which is vaguely disturbing, but in most cases we don't have a clue as to whether the chemicals exert any effect on mother or infant.[2]) Investigative medicine, toxicology, epidemiology, and engineering analysis have taken us out to their borders; but it's unruly territory.

Part of the problem is that risks evolve. In his 1803 *Essay on Population*, Thomas Malthus observed of Jenner's new vaccine, "I have not the slightest doubt that if the introduction of cowpox should extirpate the smallpox, we shall find . . . increased mortality of some other disease." Malthus was right. As any risk is reduced, others inevitably increase in the mortality and morbidity tables—though perhaps setting in later in life. Risks are evolving now as rural and agrarian risks are succeeded by urban, industrial, and medical-care risks.

At the same time that we have been learning more about risks, we have been heightening our societal aspirations for protection beyond all previous limits. We intend to help all infants get a vigorous start in life. And we strive to afford first-rate health protection (broadly defined) to all citizens, and even noncitizens, for an enormous range of risks throughout their lives. No civilization ever before has had these ambitions.

The crux: In our knowing so much more and aspiring to so much more, we have passed beyond the sheltering blissfulness of ignorance and risk-enduring resignation. This has generated considerable social apprehensiveness, which is affecting both the outlook of individuals and the functioning of institutions.

Similar phase changes have occurred historically when people became aware of specific causes of disease and deformity, as when it became clear that moral turpitude alone was not the cause of syphilis, and when societal aspirations, such as commitment to worker protection, rose. We are going through both kinds of changes at the same time.

## Risk-Management Investments

One corrective against despair is to inculcate a view of risk-management efforts as societal investments—investments that yield returns in health costs saved, productivity enhanced, disruptions reduced. Another corrective is to build frameworks of perspective within which new concerns can be appraised.

*The central methodological task is to develop ways of intercomparing sources of risk, comparing risks against risks, weighing risks against the benefits they accompany, and appraising the societal return from reducing risks.*

Comparative analysis can inform the setting of priorities and thus help avoid frittering away worry-capital on very small hazards, help prohibit unbearably large hazards, and help concentrate on hazards in the middle range that affect many people in important ways and that are susceptible to alteration.

Analysis can, for example, size up relative contributions to infant mortality, relative erosions of longevity, relative estimated mutagenic or cirrhotic potency, relative increments of insurance claims. Analysis can profile the frequency and severity of hazards to indicate how likely catastrophic accidents are. Analysis can rank risks as to their tractability or the cost-effectiveness of solution.

Sets within which risks can be compared include: *physical agents having definable effects* (such as radiation); *societal functions* (electricity generation); *geographic area* (the Ohio valley); *an industry* (glassmaking); *product class* (pest-control agents); *contributions to specified illness* (cirrhosis); or *contributions to mortality*. Analysis can indicate opportunities for risk research, reduction, redistribution, or compensation.

Social value judgments still have to be made, but such technical comparisons provide perspective, reveal the relative "payoff" of programs, and help set defensible priorities. They are essential for determining which carcinogens, or toxic waste dumps, or consumer products, or parts of a factory deserve most attention.

Important guidance can be derived from what I call risk-management opportunity analysis: estimating the information and control gains that can be expected from contemplated research or control strategies. Often it is possible, even with imprecise input numbers, to develop illuminating guidance. For example, Milton Weinstein has analyzed the cancer-reduction "payoff" of large-scale rodent carcinogenicity assays and compared it to the possible returns from investigation of beta-carotene as a dietary cancer-prevention agent.[3] Decision analysis of this kind should be considered, where possible, by administrators when developing strategy.

Especially challenging in coming years will be comparative assessment of very large, complex technological systems. Attempts to survey the risks, benefits, and costs of nuclear power in comparison with those of fossil fuel, hydropower, and other energy sources have shown how hard this is to do, especially if the assessment covers everything from fuel acquisition to waste disposal, from construction to eventual dismantlement, from mutagenesis to terrorism. European and American analyses of the risks associated with the liquefied-natural-gas industry have been very helpful in choosing among options. We will be needing more of this kind of work, and we should draw lessons from these experiences.

A constructive but discomfiting aspect of all this is that our analyses and decisions are making us face risks ever more explicitly. The Occupational Safety and Health Administration's 1983 standard for worker exposure to inorganic arsenic is a striking

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example.[4] In tightening the standard from 500 to 10 micrograms per cubic meter, OSHA concluded "that inorganic arsenic is a carcinogen, that no safe level of exposure can be demonstrated, and that 10 micrograms per cubic meter is the lowest possible level to which employee exposure could be controlled." Further,

*the level of risk from working a lifetime of exposure at 10 micrograms per cubic meter is estimated at approximately 8 excess lung cancer deaths per 1000 employees. OSHA believes that this level of risk does not appear to be insignificant. It is below risk levels in high risk occupations but it is above risk levels in occupations with average levels of risk.*

Surely this rationale is commendable (regardless of whether the particular numbers adopted survive current dispute).

Candor is laudable—and, besides, risks can be calculated from the record even if authorities don't state them—but the explicitness is unsettling. This is the kind of knowledge that raises tragic awareness.

Tragic choices inescapably will have to be confronted—not just made (we do that already), but confronted. We are straining our resources to the margins both in managing these environmental health risks and in providing expensive remedial medical care, such as renal dialysis. We will not be able to afford everything for everybody.

*A consequent challenge for the agenda is to work from these comparative assessments toward defining "insignificant" or "negligible" risk, "acceptable" or "tolerable" risk, and "intolerable" or "unacceptable" risk, and developing guidelines for decision.* These notions cannot be derived from abstract principles, but must be defined by debate and inferred from how people actually deal with risks.

We should not expect to arrive at precise and invariant demarcations but at working distinctions that can be re-evaluated at any time in the light of new knowledge or revised social values. For example, the Food and Drug Administration has ruled the risks of several hairdyes and food colorings "insignificant" compared to other hazards, and the Environmental Protection Agency has banned commerce in polychlorinated biphenyls (PCBs), which it has deemed intolerably hazardous; either judgment could change.

Analysis usually does *not* consist in anything so crass as asking, "How much is one's life worth?" but rather in asking such questions as, "What marginal investment in precaution will preserve marginally how many lives, or person-life-years, or eyes from being lost to [some] hazard?" or, "Where can a given investment be most effective in protecting people?"

## Decisionmaking Frameworks

Like the Zen query about the sound of one hand clapping, it doesn't make much sense to ask only about risks without enquiring about benefits and costs. Risk levels that we might tolerate for some benefits, such as protection against fatal disease, we might well hold unacceptable if associated with, say, only cosmetic benefits.

We are going to have to admit most of our decision frameworks really are only versions of one framework. Regulation drafters often distinguish between "absolute no-risk" rules, benefit/risk balancing, cost-effectiveness, "best available technological control," protection "as low as is reasonably achievable," and the like. But, really, if actual implementation is considered, these are distinctions without differences: "zero-risk" rules simply have been ignored when obeying them would be too costly for the benefit achieved; "available" control and "reasonable" achievability have been defined, pragmatically, by benefit-cost considerations; and although cost-effectiveness analysis does not estimate benefits, it assumes the benefits to be worth the effectively spent costs.

*Another task for the agenda is to seek ways for reconciling non-expert popular opinions about risk issues with those of experts.* This problem

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was exemplified a few years ago when Nobel biochemist Rosalyn Yalow wrote a *New York Times* "op-ed" article (January 31, 1981) about the closing of sites for disposal of low-level radioactive waste from biomedical research, in which she complained:

*The Nuclear Regulatory Commission should have proposed a change in regulations long before the sites were closed down. Why didn't it? The regulators were responding not to the* real *risk but rather to the public's fears of radiation at any level . . . . We must respond to real risk, not perception of risk.*

Such disputes strongly test republican forms of government, in which legitimated expert authorities are charged with making determinations on behalf of the public. They also entail a problematic distinction between "subjective" and "objective" opinions: all thinking is, by definition, "subjective"; but questions such as what relative contribution different sources make to people's radioactivity exposure can, by scrutiny within the organized skepticism of science, become authenti-

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cated into knowledge that is reliable—knowledge that can describe and predict with consistency and accuracy *what is* and *what will happen* in the physical and biological world.

While I reserve my right to evaluate the social importance of Dr. Yalow's radwaste differently from the way she might, I also protest that I don't want my radiation protection determined by public-opinion polls! (Parenthetically I hasten to say, also, that I object to the arrogant term, "real risk"; one person's objectivity is another's subjectivity, and, in science as elsewhere, many value biases influence construction of "the real.") Comparisons and the exercise of making them can help resolve differences in views.

Psychologists are studying how people perceive risks, and decision theorists are developing typologies of values and valuation processes. I am skeptical of much of this work, which I find simplistic. Few of its results have found application in policy design or decisionmaking. Opinion polls that don't force respondents to make tradeoffs are not very revealing. Too, perceptions are subject to rapid shifts: hydropower probably will continue to be viewed as harmless, until the day a large dam breaks over a major population center.

We do need better mechanisms for soliciting and responding to the public's (or, various publics') opinions. Risk-management regimens must strive to make just and efficient investment of resources. But they also must evaluate the public's preferences and allay public apprehensions and the instabilities they induce. This latter function should not be underrated, as some former government officials would testify. Inversely, we need better ways of communicating experts' evaluations to the public.

Much can be learned by studying people's willingness to pay for hazard reduction, adopt protective measures, choose among medical therapeutic options, insure themselves and others against loss, and compensate those who incur harm from occupational exposure or natural disaster.

## Anticipating Changes

*The agenda must become more self-reflexive, to anticipate demographic and hazard-apprehension changes.* As the population ages, the spectrum of illnesses changes. Degenerative illnesses, such as heart disease and cancer, have of course been increasing (although these two now may have plateaued). In addition to acutely fatal illnesses, concern is growing over long-term debilitations, such as arthritis, hayfever, and cirrhosis, and over a variety of renal, neurological, immunological, endocrinological, and behavioral illnesses. Many of these have multiple-factor environmental and "lifestyle" causes and are difficult to assess. With many more women entering the workplace and workers migrating extensively, workforces are becoming much more heterogeneous, thereby complicating risk assessment and management. Reproductive and genetic hazards are very hard to analyze and are especially disturbing.

We need to establish solid health-data baselines upon which to evaluate these concerns. Reproductive issues are a good example: we need to know much more about the incidence of sterility, spontaneous abortion and miscarriage, and premature and low-birthweight birth; about sperm counts, morphology, motility, and enzymology; and about birth defects. In public-health emergencies, such as those at Seveso, Love Canal, and Three Mile Island, investigators probe many such indices. We know neither the baseline status for most communities, nor the mechanisms through which harm occurs, nor what comprises appropriate control populations for comparison. The same analytic limitations afflict chromosome studies, assays of blood "markers," and psychological evaluation.

*Finally, we must prepare for coming confrontations with paternalism, self-determination, and protective discrimination.* "Discrimination" need not be pejorative. We have always selected people differentially for jobs, military tasks, and other functions. Genetic screening as a condition for employment is raising this social issue, as is debate over how much Clean Air regulation should protect people who suffer from asthma and emphysema. Allergies are common and staggeringly diverse. As we learn more about immunological and other basic characteristics of people, these complexities and diversities will become more evident.

Almost certainly we will want to discriminate between older and younger, the strong-backed and the weak-framed, potential childbearers and those past childbearing, potential fathers and those past fathering, the overweight stroke-prone and the cardiac robust, smokers and nonsmokers. This will conflict directly with equal job opportunity and other social goals. These issues must be discussed now, before they grow too far without broad examination and debate.

## Managed Tragedy

To conclude, I would once again remind us of the essentially tragic nature of our risk awarenesses, decisions, and commitments, insisting all the while that we are in many ways better off than ever before, and noting that tragedy *is* humanness.

The difference from the past is that—though it is discomfiting—this conjunction of greatly improved science with heightened societal aspirations now puts us in a position to *manage* aspects of the tragedy as it unfolds. Value issues are as much contended as the "facts" are. Experts perform centerstage and in the wings. All of us chant from the citizens' chorus.

### NOTES


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